Journal of Taibah University Medical Sciences (2023) 18(6), 1288–1298

Taibah University

Journal of Taibah University Medical Sciences

www.sciencedirect.com

Original Article

Effects of argan spinosa oil in the treatment of diaper dermatitis in infants and toddlers: A quasi-experimental study

Eman S. Alsatari, MSN [a,*], Nihaya AlSheyab, PhD [b], Juliana L. D'Sa, PhD [c], Huda Gharaibeh, PhD [d], Sami Eid, PhD [a], Esra'a A. Al-Nusour, MSN [e] and Audai A. Hayajneh, PhD [f]

[a] *Department of Nursing Education and Development, King Saud University Medical City, Riyadh, KSA*
[b] *Department of Maternal and Child Health Nursing, Faculty of Nursing/Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan*
[c] *Department of Maternal and Child Health Nursing, College of Nursing, King Saud University, Riyadh, KSA*
[d] *Department of Maternal and Child Health Nursing, Faculty of Nursing, Jordan University of Science and Technology, Irbid, Jordan*
[e] *Department of Paramedics, Prince Al Hussein Bin Abdullah II Academy for Civil Protection, AlBalqa Applied University, Salt, Jordan*
[f] *Department of Adult Health Nursing, Faculty of Nursing, Jordan University of Science and Technology, Irbid, Jordan*

Received 28 December 2022; revised 20 April 2023; accepted 10 May 2023; Available online 22 May 2023

الملخص

أهداف البحث: التهاب الجلد الناتج عن الحفاظ هو أحد أكثر الأمراض الجلدية شيوعا لدى الأطفال. الأدوية شائعة الاستخدام للعلاج لها العديد من الآثار الجانبية، مما يفرض الحاجة إلى تقييم استراتيجيات علاجية آمنة. لذلك، فإننا نهدف إلى مقارنة فعالية زيت الأرغان سبينوزا ومرهم الهيدروكورتيزون 1٪ على شفاء التهاب الجلد الحفاظي.

طريقة البحث: أجريت دراسة شبه تجريبية في الأردن على أطفال تتراوح أعمارهم بين عامين أو أقل يعانون من التهاب الجلد الحفاظي الخفيف إلى الشديد. في البداية، تم تسجيل 73 مشاركا في مجموعة زيت الأرغان سبينوزا و 74 مشاركا في مجموعة مرهم الهيدروكورتيزون 1 ٪. تم تعيينهم بشكل عشوائي، بعد إجراء القياس الأساسي لالتهاب الجلد الحفاظي. تم قياس الشفاء في الأيام 1و3 و 7 من خلال الزيارات المنزلية، باستخدام مقياس تصنيف مكون من 5 نقاط. تم تحليل البيانات باستخدام نماذج فيشر، مان ويتني يو، ومعادلات التقدير المعممة من خلال برنامج اس بي اس اس الإصدار 25.

النتائج: من بين 147 طفلا تم تسجيلهم، أكمل 140 منهم الدراسة. لوحظ انخفاض في درجات التهاب الجلد الحفاظي في كلا المجموعتين. بعد استبعاد العوامل المربكة، كشفت نماذج معادلات التقدير المعممة أن الأطفال الذين استخدموا علاج زيت الأرغان سبينوزا كانوا أقل عرضة بنسبة 25 مرة للإصابة بدرجات التهاب الجلد الحفاظي الحاد وتحسنوا بشكل أسرع من الأطفال الذين استخدموا الهيدروكورتيزون 1٪. كشف الانحدار اللوجستي المتعدد على بيانات خط الأساس أن استخدام كريم الحاجز وتكرار الاستحمام مرة واحدة في الأسبوع كانت تنبؤية بحدوث التهاب الجلد الحفاظي.

الاستنتاجات: يعتبر زيت الأرغان سبينوزا أكثر فعالية في علاج التهاب الجلد الحفاظي ويمكن استخدامه كخيار تكميلي. ومع ذلك، ستكون التجارب السريرية الإضافية على عينات أكبر ضرورية لتأكيد النتيجة وإصدار حكم موثوق.

الكلمات المفتاحية: زيت الأرغان سبينوزا؛ التهاب الجلد الحفاظي؛ الرضع؛ الأطفال الصغار؛ الأطفال؛ مرهم هيدروكورتيزون 1٪

Abstract

Objectives: Diaper dermatitis (DD) is one of the most common dermatological disorders in children. Commonly used drugs for treatment have several adverse effects; therefore, assessment of safe therapeutic strategies is necessary. We, therefore, aimed at comparing the efficacy of argan spinosa oil and 1% hydrocortisone ointment on DD healing.

Methods: A quasi-experimental study was conducted in Jordan on children 2 years old or younger with mild to severe DD. Initially, 73 participants were enrolled in the argan spinosa oil group, and 74 participants were

* Corresponding address: King Saud University Medical City, Riyadh 12372, KSA.
E-mail: ealsatari@ksu.edu.sa (E.S. Alsatari)

Peer review under responsibility of Taibah University.

ELSEVIER Production and hosting by Elsevier

 https://doi.org/10.1016/j.jtumed.2023.05.008

enrolled in the 1% hydrocortisone ointment group. Participants were assigned to groups randomly after the baseline measurement of DD. Healing was measured on a 5-point scale on days 1, 3, and 7, through home visits. Data were analyzed with Fisher's exact test, the Mann−Whitney U test, and generalized estimating equation (GEE) models in SPSS version 25 software, with a significance level of $p < 0.05$.

Results: Of the 147 enrolled children, 140 completed the study. A significant decrease in the DD grades was observed in both groups. After the exclusion of confounding factors, the GEE models revealed that children treated with argan spinosa oil were approximately 0.25 times less likely to have severe DD grades and to show faster improvement than children treated with 1% hydrocortisone ($p < 0.025$). Multiple logistic regression on the baseline data revealed that the use of barrier cream (OR: 0.35; 95% CI: 0.18, 0.72; $p = 0.004$) and a frequency of bathing one or fewer times per week (OR: 1.15; 95% CI: 0.65, 2.10; $p = 0.002$) predicted DD occurrence.

Conclusion: Argan spinosa oil is more effective than 1% hydrocortisone in healing DD and might be used as a complementary treatment. However, further clinical trials on larger samples will be essential for confirming the results and making a reliable judgment.

Trial registration: NCT04210674.

Keywords: Argan spinosa oil; Children; Diaper dermatitis; Hydrocortisone 1% ointment; Infant; Toddler

Introduction

Diaper dermatitis (DD) is among the most common dermatological disorders in neonates, infants, and toddlers.[1] Approximately 25−50% of children between 6 and 12 months of age experience this disorder.[2,3] The rates vary globally, from as low as 16% in the United Kingdom to 43.8% in China, 75% in the United States of America, and 87% in Japan.[4−8] Varied prevalence has also been reported in Middle Eastern countries. For instance, the prevalence in Iran is 50.9%,[9] whereas that in Turkey is 67.3%.[10] Most children below 2 years of age are at risk of developing DD, owing to a lack of toilet training. The prolonged wetness in an occlusive diaper environment predisposes the skin to mechanical injury and can lead to DD.[6] If untreated, DD may progress from localized erythema to secondary infection caused by common pathogens, such as *Staphylococcus*, *Streptococcus*,[11] and *Candida albicans*.[12]

Diaper dermatitis is characterized by erythema, papules, and pustules at the diapered site. The most common causes of DD are friction, and prolonged exposure to urine or feces, which lead to elevated skin pH.[13] Digestive enzymes such as pH-sensitive proteases and lipases in the feces can disrupt proteins and lipids in the epidermal layer of the skin, thus resulting in a risk of overhydration and establishing a route for infection. Furthermore, the increase in the skin pH level and the alkaline environment facilitate microbial colonization.[14] Therefore, DD can be prevented by protecting the skin at the diaper site, decreasing friction, maintaining pH, and preventing overhydration.[11,14] Gentle cleansings, exposure of the area to fresh air, frequent diaper changes, use of superabsorbent diapers, and application of emollients or topical barrier creams are recommended.[13] Topical agents such as corticosteroids, antimicrobial agents, broad-spectrum antibiotic creams,[14,15] and anti-fungal ointments are used for treating DD in children.[16,17] Most plant-based creams are readily available and generally do not have significant adverse effects. However, long-term topical application of the widely used 1% hydrocortisone ointment is known to cause epidermal atrophy, hypothalamic−pituitary−adrenal axis suppression, and granuloma gluteale infantum.[18−20] Therefore, some patients seek alternative botanical/plant-based agents, such as 25% henna oil cream,[21] aloe vera cream,[22] water-in-oil emollient cream, and olive oil cream.[23] Most plant-based creams are easily available and do not have adverse effects.

Botanical/plant-based remedies have anti-microbial and anti-inflammatory properties.[14,24,25] Some botanical agents have been found to be effective in treating DD. For instance, a clinical trial has demonstrated that *Calendula officinalis* and aloe vera are effective in decreasing the severity of DD. However, aloe vera cream is more effective than *C. officinalis* in diminishing the rash sites.[26] The rate of reduction of DD severity is higher when botanical agents are used rather than topical corticosteroid agents, such as hydrocortisone.[14] In a comparison of henna oil with hydrocortisone 1% cream, higher rates of improvement in DD signs have been reported with henna oil.[21] Similarly, several other plant-based oils, such as water-in-oil emollient cream and olive oil cream, have shown higher rates of improvement in signs of DD healing.[23]

Argan spinosa oil is a plant-based oil prepared by pressing slightly roasted kernels of the argan tree (*Argania spinosa* L). The high linoleic acid content of argan spinosa oil may contribute to its traditional use as a treatment for skin inflammation. Unsaponifiable matter constitutes 1% of argan spinosa oil, which has a composition of 37% carotenes, 8% tocopherol, 20% triterpene alcohols, 29% sterols, and 5% xanthophylls.[27] Known for its healing properties, this oil is commonly used for the treatment of pimples/acne, skin burns, chickenpox, and other dermatological conditions.[28] To our knowledge, no studies to date have reported the efficacy of argan spinosa oil in treating DD. An extensive literature search did not yield any results on the effect of argan spinosa oil in treating DD. This study is the first to determine the effect of topical application of argan spinosa oil in the treatment of DD, specifically in terms of the rate of healing, on the basis of a comparison with 1% hydrocortisone ointment. The findings of the study suggest that argan spinosa oil may provide a non-

pharmacological, inexpensive, and accessible option for the treatment of DD.

Materials and Methods

Study design and participants

This quasi-experimental study was undertaken in 150 children attending the outpatient clinics at three university-affiliated governmental hospitals, and three primary health-care centers from February to May 2018 in Irbid, Jordan. The children were recruited if they had a diagnosis of mild to severe DD, they were between 1 and 24 months of age, and their mothers consented to participate in the study. Children were excluded if they had co-morbidities (kidney disorders, malignancy, oral or genital thrush, or psoriasis), mineral deficiencies requiring specialized treatment, or high-protein diets. Those who received oral antibiotics or topical non-steroidal anti-inflammatory drugs; who had a history of allergic reactions to the active ingredients of argan spinosa oil or 1% hydrocortisone ointment; or who were participating in other studies were also excluded.

Initially, 150 children were recruited to participate in the study. After the initial interview, three mothers who declined to participate were excluded from the study. The 147 children were randomly assigned to an argan spinosa oil group (n = 73) and 1% hydrocortisone group (n = 74). Of these, seven were lost to follow-up: three from the argan spinosa oil group and four from the 1% hydrocortisone group. Thus, the final sample constituted 140 children (n = 70, in each group; Figure 1).

Sample size

The sample size was calculated with the formula $n = \frac{2\sigma^2(z_{1-\alpha/2}+Z_{1-\beta})^2}{(\mu_1-\mu_2)^2}$,[29] given standard normal variate at 5% type I error ($p < 0.05$) is 1.96. The standard normal variate for a power of 80% was 0.84, and the variance, i.e., the squared deviation from the mean (σ^2), was 2.105.[29] No previous studies have described the use of argan spinosa oil in the healing of DD. Thus, we conducted a pilot study on 20 children who were not part of the final study. The mean healing at baseline and in the argan spinosa oil group was 8.46, and that in the 1% hydrocortisone ointment group was 7.44. The calculated sample size was 134. On the basis of the assumption of a 10% attrition rate, the necessary sample size was determined to be 147. Consequently, 150 children were recruited, and 75 children were assigned randomly to each study group.

Sampling technique

In Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) software version 25.0, we created a randomization plan and randomly assigned the children to one of two coded groups: code "A" (argan spinosa oil group) and code "B" (topical 1% hydrocortisone ointment group). The envelopes were sequentially numbered, sealed, and randomized with code A and code B. After a pediatrician diagnosed each child with DD, the envelope was given to the pediatrician, who prescribed either argan spinosa oil or 1% hydrocortisone to the children according to the randomization plan.

Outcome measures

The two outcome measures were healing and the rate of improvement. The first outcome was measured with the Diaper Dermatitis Grading Scale (DDGS). The skin was assessed and interpreted on a scale of 0–4. Normal skin (no rash or erythema, soft, smooth, and clear) was graded as 0, whereas, grades 1–4 represented varied grades of dermatitis, as follows: grade 1 = mild irritation or rash (slight erythema of the entire diaper area or patchy, localized areas); grade 2 = irritation or rash (definite erythema of the diaper area totally or in localized areas, with erythematous papules), grade 3 = moderate to severe irritation or rash (more intense erythema, with or without oozing, in a generalized pattern and associated with papules, pustules, or superficial ulceration; and extreme irritation or rash) and grade 4 = extreme irritation or rash (extreme and considerable erythema involving the entire diaper area, associated with oozing papules, pustules, and erosion).[30] The face validity and content validity of the scale have previously been reported to be good by a panel of professionals in the fields of dermatology and skin and wound care.[30,31] The scale developed by Davis et al. in 1986[30] has been used in previous studies.[17,22,32] The second outcome measure, the rate of improvement, refers to the decrease in DD grade over the treatment days (for example, a decrease in DD grade from 4 on day 1 to grade 0 on day 5). The rate of improvement in DD grade was assessed on days 1, 3, and 7 through home visits, by a pediatrician and research assistant.

Intervention

Argan spinosa oil group

Argan spinosa oil produced in Pakistan by Hemani Company and procured in Jordan was used in our study. The argan spinosa oil was in edible form, extracted from the hard cores of the argan fruit kernels, and prepared through the traditional hand cold-pressing method. The oil was produced in August 2017 and had an expiry date of July 2021. It was composed of campesterol (0.2%), avenasterol (4.1%), beta-tocopherol (0.1%), gamma-tocopherol (86.5%), delta-tocopherol (7.0%), alpha-tocopherol (5.5%), spinasterol (44.4%), and tocopherol totaux (738 mg/kg).

The pediatrician instructed the mothers in the argan spinosa oil group to apply the oil on the affected areas four times per day, for seven consecutive days, after washing the area with warm water, drying it, and exposing it to fresh air; to change the diaper; and to ensure that the borders of the lesion were covered when the argan spinosa oil was applied. The mothers were also advised to stop the treatment in the event of any local reaction or allergic reaction to the oil, and to report such responses to the pediatrician immediately. In addition, they were instructed to avoid using wet wipes,

essence-containing soaps, barrier cream, or any other medications during the study period.

Hydrocortisone ointment group

The 1% hydrocortisone ointment for topical use had a composition of 1% econazole nitrate and 0.1% triamcinolone acetonide, and was produced by Hayat Pharmaceutical Industries. The ointment was produced in March 2017 and had an expiry date in February 2019; it was procured from pharmacies in Northern Jordan. Instructions regarding the application of 1% hydrocortisone were similar to those for the argan spinosa oil group.

Data collection

Data were collected from February to May 2018 from children who were enrolled in the three participating hospitals and primary healthcare centers. The mothers of the children were informed of the study procedure, and their written consent was obtained. They were made aware that participation was voluntary, and they had the right to withdraw from the study at any time without consequences. Confidentiality and anonymity were maintained by assigning a number to each participant. Furthermore, privacy was maintained throughout the data collection process.

On the baseline day (day 0) the pediatrician graded the DD on a 5-point grading scale.[30] The pediatrician was given a sealed envelope and prescribed either argan spinosa oil or 1% hydrocortisone accordingly. Depending on the prescription, the pediatrician conducted a skin sensitivity test by applying either argan spinosa oil or 1% hydrocortisone on the upper part of the child's arm and observing the skin for any reaction after 10 min. None of the children were found to be allergic to either agent. After ensuring the safety of the agent, the first author collected baseline information from the mother, through face-to-face interviews using a structured checklist developed by the first author. The structured checklist included specific items regarding the characteristics of the child (age, sex, and weight) and mother (age, parity, education level, job, income, nationality, and home setting: rural, semi-urban, and urban). The type of food given to the child, general state of health of the child, use of antibiotics before the DD episode, type of diapers used, number of diapers used per day, type of wipes used, use of barrier cream, frequency of bathing, and previous history of DD (medication used in previous episodes, duration of episode and frequency of DD per month) were also assessed at baseline.

On days 1, 3 and 7, the pediatrician assessed and graded the DD site through direct observation during the home visits. The assistant researcher assessed compliance with treatment through video calls on days 2, 4, 5, and 6 (Figure 2).

Safety

A safety certificate was procured from the producer of the argan spinosa oil (Hemani Company). Furthermore, a skin sensitivity test was performed before the intervention. Mothers were instructed to discontinue treatment if any allergic or adverse reactions were observed, and to consult the pediatrician immediately. None of the children had any reactions.

Statistical analysis

Descriptive statistics (proportions, percentage, median, and interquartile range (IQR)) were used to describe the outcome variables. Fisher's exact test for categorical variables, and Mann–Whitney U test for continuous variables were used to assess the associations and differences between variables in both groups, as well as to determine both groups' homogeneity at baseline. Significance was tested at an alpha level of $p < 0.05$.

Ordinal logistic regression analysis using generalized estimating equation (GEE) models was performed to describe the rate of improvement (changes in DD grades over time) rather than absolute values at different time points. The GEE model enables analysis to determine the progress and variability within participants over day 1, day 3, and day 7, showing changes in the proportions in each group.

Initially, univariate logistic regression analysis was performed to predict DD-associated factors by calculation of odds ratios (OR) and 95% confidence intervals (CI). Independent associations of the retained variables that were significant at $p < 0.05$ were then entered into the multivariate logistic regression analysis (by using a backward elimination model) to identify the final significant predictors and risk factors with $p < 0.05$, while simultaneously controlling for potential confounders. The statistical analyses were performed in SPSS Statistics for Windows, 25.0 (IBM Corp., Armonk, NY, USA), and significance was assessed at alpha = 0.05 with two-tailed tests.

Results

The data for the final sample of 147 children in the argan spinosa oil group (n = 73) and 1% hydrocortisone group (n = 74) were analyzed (Figure 1).

Baseline characteristics of the mothers and children

The median age of the mothers was 28 years (IQR = 23–22); the majority were multiparous (74.3%) Jordanian nationals (95.0%) from a nuclear family (72.9%) residing in an urban area (70.0%). Almost two-thirds (64.3%) had an educational qualification of high school or higher, and an income of ≤300 Jordanian dinars (44.3%). With regard to the children's characteristics, 50.0% were boys, with a median age of 14 months (IQR = 6–18) and a median weight of 10 kg (IQR = 7.3–12). The median stool frequency was 2 (IQR = 1–3). The majority (98.6%) used disposable diapers, and 80.7% of mothers changed the diapers fewer than six times per day. More than one-third used wet wipes (36.4%) or alcohol wipes (35.0%), and more than half (55.0%) used soap multiple times per day to clean the diapered area, whereas only 45.0% exposed the diapered area to air for drying. Most gave baths to their children less than once per week. The median duration of previous episodes of DD was 3 days (IQR = 2–4). Most mothers had received information

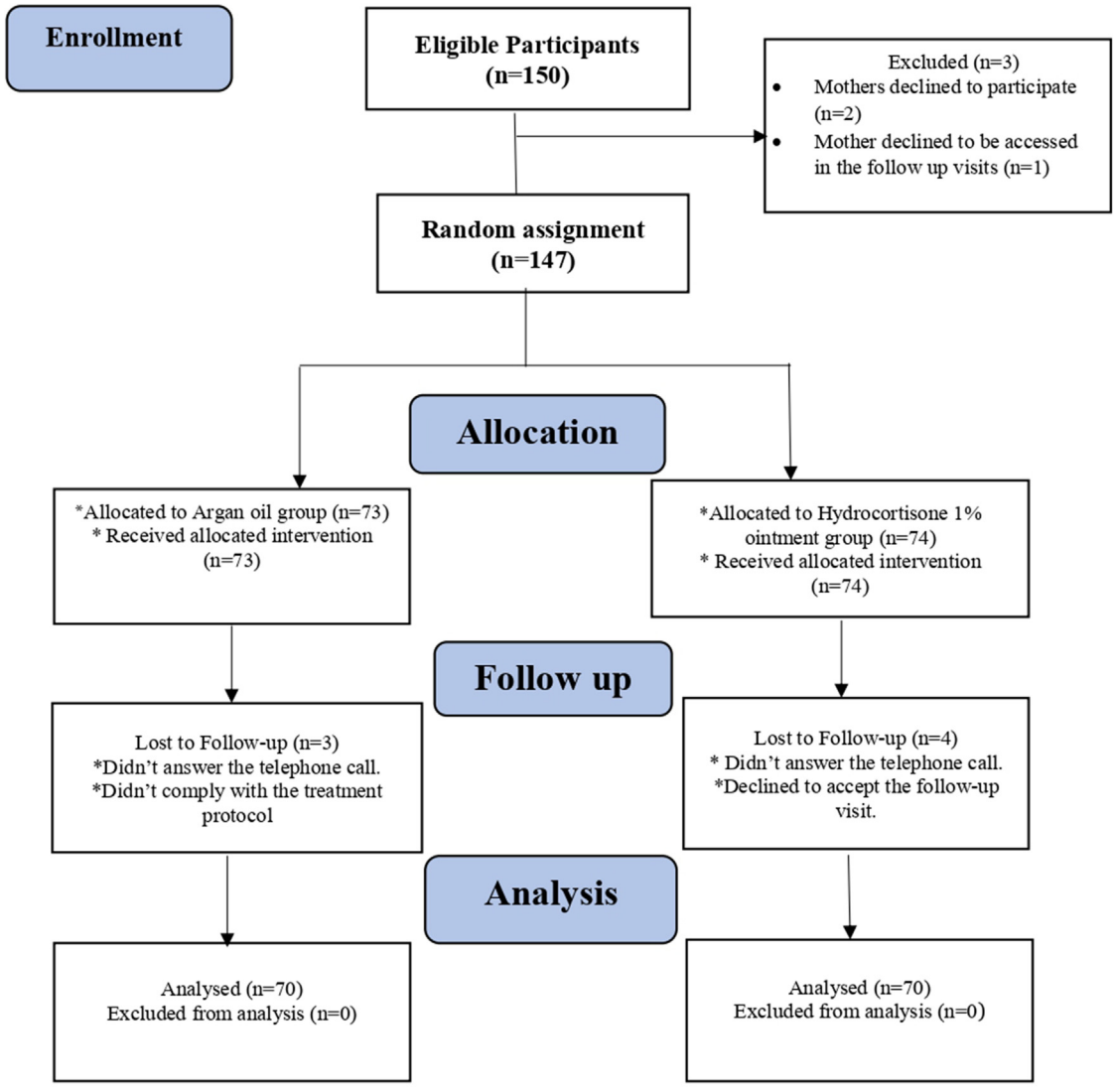

Figure 1: Study flowchart.

about DD from family members (44.3%). Both the argan spinosa oil group and the 1% hydrocortisone group were similar in all maternal characteristics, except in employment status: a significantly higher number of mothers were employed in the argan spinosa oil group ($p = 0.025$) than the 1% hydrocortisone group. Both groups were similar in all characteristics, except that a significantly higher number of children in the 1% hydrocortisone group had experienced DD previously ($p = 0.400$), and the frequency of use of barrier cream was higher in the argan oil group ($p = 0.031$) (Table 1).

Outcomes of diaper dermatitis in both groups

Treatment effects were computed as totals to demonstrate the rate of improvement in the healing level during days 1, 3, and 7 in both groups. In total, 8.6% ($n = 6$) of children in the argan spinosa oil group started DD healing on day 1, as compared with 2.9% ($n = 2$) in the 1% hydrocortisone group. The rate of healing was significantly higher in the argan spinosa oil group than the 1% hydrocortisone group ($p = 0.026$). Furthermore, the risk ratio for the start of improvement by day 1 was 0.600 in the argan spinosa oil group with respect to the 1% hydrocortisone group (95% CI: 0.138, 2.613). A significantly higher number of children showed complete healing by day 3 in the argan spinosa oil group ($n = 47$; 67.1%) than the 1% hydrocortisone group ($n = 32$; 45.7%) ($p < 0.001$). In contrast, on day 7, a significantly higher percentage of children had healed in the 1% hydrocortisone group ($n = 69$; 98.6%) than the argan spinosa oil group ($n = 67$; 95.7%); ($p < 0.001$). In addition, the risk ratio for complete healing was 2.09 in the argan spinosa oil group with respect to the 1% hydrocortisone group (95% CI: 0.185, 23.59) (Table 2; Figure 3).

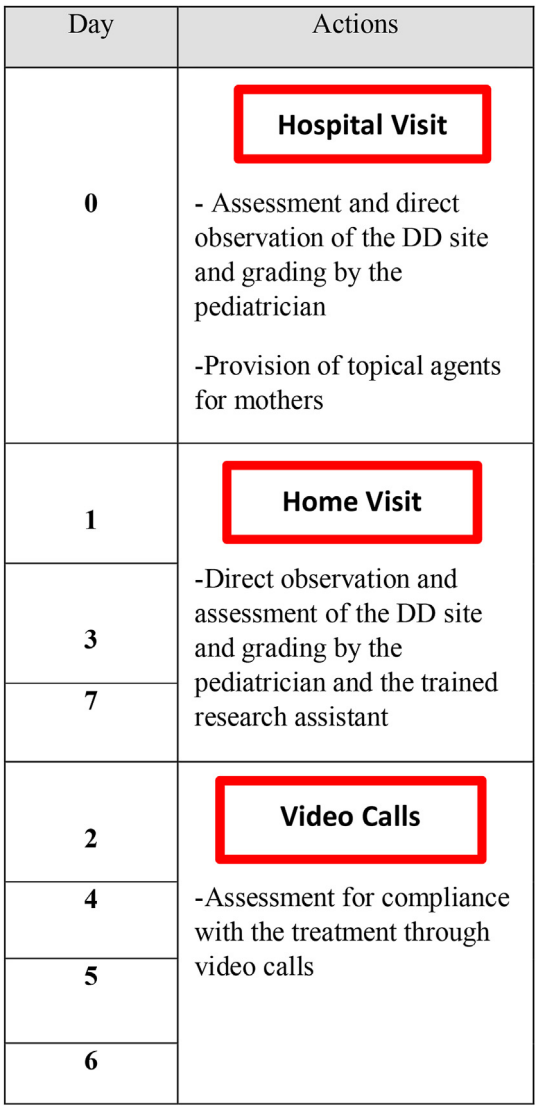

Figure 2: Schedule of visits.

Effects of argan spinosa oil in the healing of diaper dermatitis

The effects of argan spinosa oil on the healing level were compared with those of 1% hydrocortisone (Table 2). Ordinal logistic regression analysis using the GEE models revealed a significant overall potential confounding effect of the following factors: use of barrier cream, the mother's employment status, and the mother's previous experience in caring for a child with DD. After the exclusion of confounding factors, the GEE models revealed that children treated with argan spinosa oil were approximately 0.25 times less likely to have higher DD grades than children treated with the 1% hydrocortisone (OR: 0.246; 95% CI: 0.072, 0.842; $p = 0.025$). The results indicated that argan spinosa oil was more effective than 1% hydrocortisone ointment in healing DD.

Predictors of diaper dermatitis

In choosing predictor variables, we used a two-step procedure. The grade of DD at baseline (day 0) was the dependent variable. The independent variables entered in the model as potential predictors of DD. Furthermore, maternal and child characteristics were assessed as potential predictors of DD. Of the 17 factors, only two—the use of barrier cream and a frequency of bathing one or fewer times per week—were significantly associated with DD ($p < 0.050$). The use of barrier cream was a protective factor against the development of DD; children treated with barrier cream were 0.52 times less likely to develop DD (95% CI: 0.27, 0.99; $p = 0.047$) than those who were not treated with a barrier cream. In contrast, children who were less frequently bathed (once per week or less) had more than twice the risk of developing DD (OR: 2.01; 95% CI: 1.07, 3.75; $p = 0.029$) as those who were bathed more than once per week. After analysis with the backward conditional method, both use of barrier cream (OR: 0.35; 95% CI: 0.18, 0.72; $p = 0.004$) and the frequency of bathing/showering one or fewer times per

Table 1: Background characteristics of mothers and children at baseline.

Background	Arganoil n = 70	Median	IQR	Hydrocortisone 1% n = 70	Median	IQR	P value
Maternal characteristics							
**Mother's age, years		28.5	(23.8,33)		27	(23,32)	0.137
Nationality, Jordanian	67 (95.7)			66 (94.3)			1.000
Residence, urban	54 (77.0)			44 (62.9)			0.096
Type of family, nuclear family	54 (77.1)			48 (68.6)			0.342
Educational status, high school or higher	49 (70.0)			41 (58.6)			0.217
Employment, yes	21 (30.0)			10 (14.3)			**0.041**
Income, Jordanian dinar (1 JD = 1.41 USD)							
≤300	26 (37.1)			36 (51.4)			0.370
301−500	26 (37.1)			21 (30.0)			
≥501	18 (25.7)			13 (18.6)			
Parity, primipara	18 (25.7)			10 (14.3)			0.138
Parity, multipara	52 (74.3)			60 (85.7)			
Source of information							
Family member	34 (48.6)			28 (40.0)			
Health professional	33 (23.0)			31 (44.3)			0.637

(*continued on next page*)

Table 1 (*continued*)

Background	Arganoil n = 70	Median IQR		Hydrocortisone 1% n = 70	Median IQR		P value
Media	05 (07.1)			06 (08.6)			
Others	08 (11.4)			05 (07.1)			
Child characteristics							
Child sex, male	31 (44.3)			39 (55.7)			0.237
Child age, months							0.078
(1−6)	24 (34.3)			14 (20.0)			
(7−12)	10 (14.3)			20 (28.6)			
(13−18)	22 (31.4)			18 (25.7)			
(19−24)	14 (20.0)			18 (25.7)			
**Child weight, kilograms		10	(7.2,12)		10	(7.4,12)	0.967
Breastfeeding, yes	28 (40.0)			30 (42.9)			0.864
Type of diaper, disposable diapers	69 (98.6)			69 (98.6)			1.000
Non-disposable diapers (cloth)	01 (01.4)			01 (01.4)			
Type of wipes							
Wet wipes	31 (44.3)			20 (28.6)			0.271
Alcohol wipes	21 (30.0)			28 (40.0)			
Never used	18 (25.7)			22 (31.4)			
Previous experience, yes	54 (77.1)			63 (90.0)			**0.046**
Frequency of diaper changing							
<6 times per day	56 (80.0)			57 (81.4)			1.000
≥6 times per day	14 (20.3)			13 (18.6)			
Barrier cream, yes	29 (41.4)			17 (24.3)			**0.024**
**Stool frequency, times per day		2	(1,3)		2	(1,3)	0.844
Bathing							
≤1 time per week	40 (57.1)			48 (68.6)			0.221
>1 time per week	30 (42.9)			22 (31.4)			
**DD episode duration, days		3	(2,4.3)		3	(2,4)	0.950

"Previous experience" indicates that participants experienced DD before study enrollment; "Previous episodes of diaper dermatitis" indicates the number of times the participants had DD before participation in the study.
*Comparisons with Fisher's exact test for categorical variables.
**Comparisons with Mann−Whitney U test for continuous variables.
**Significant $p < 0.05$.

Table 2: Rate of improvement between groups at baseline, and the first, third, and seventh days of treatment.

Group Severity of diaper rash[a]		Argan oil group (n = 70)		Hydrocortisone 1% group (n = 70)		Total cases with DD (1−4) in the argan oil group	Total cases with DD (1−4) in the Hydrocortisone 1% group	P value
		n	%	n	%	n (%)	n (%)	
Day 0	Grade 1	23	32.9	21	30.0	70 (100)	70 (100)	0.026
	Grade 2	22	31.4	16	22.9			
	Grade 3	09	12.9	11	15.7			
	Grade 4	16	22.9	22	31.4			
Day 1	Grade 0	06	08.6	02	02.9	64 (91.4)	68 (97.1)	<0.001
	Grade 1	37	52.9	32	45.7			
	Grade 2	17	24.3	14	20.0			
	Grade 3	08	11.4	17	24.3			
	Grade 4	02	02.9	05	07.1			
Day 3	Grade 0	47	67.1	32	45.7	23 (33.0)	38 (54.3)	<0.001
	Grade 1	15	21.4	28	40.0			
	Grade 2	05	07.1	09	12.9			
	Grade 3	01	01.4	01	01.4			
	Grade 4	02	02.9	00	00.0			
Day 7	Grade 0	67	95.7	69	98.6	03 (04.3)	01 (01.4)	<0.001
	Grade 1	01	01.4	01	01.4			
	Grade 2	00	00.0	00	00.0			
	Grade 3	00	00.0	00	00.0			
	Grade 4	02	02.9	00	00.0			

[a] Severity of diaper rash, defined according to the scale: 0 (normal skin), 1 (mild irritation), 2 (moderate irritation), 3 (moderate-severe irritation), and 4 (extreme irritation).

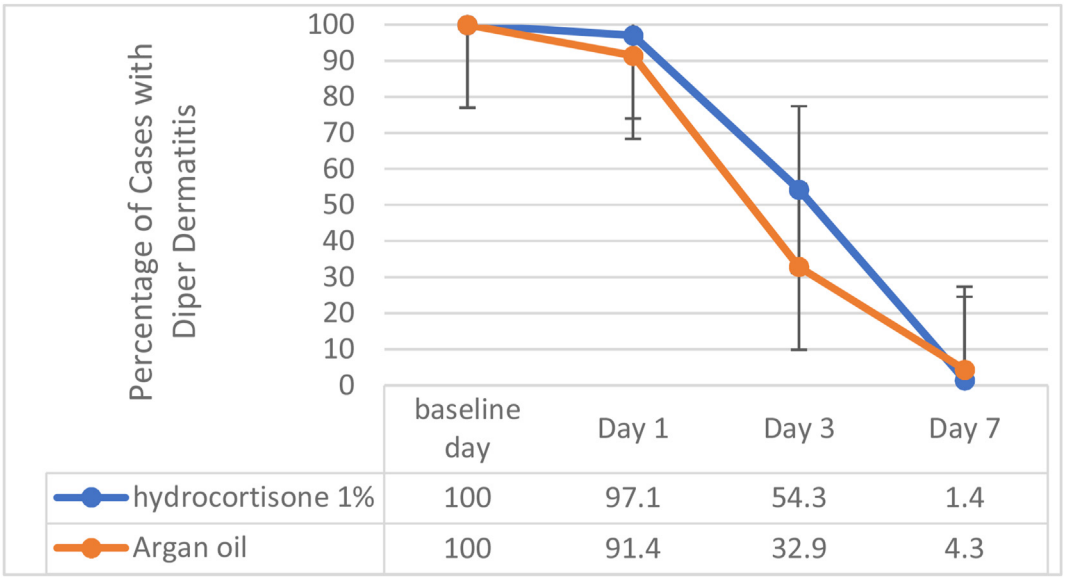

Figure 3: Proportions of diaper dermatitis grades in both groups.

week (OR: 1.15; 95% CI: 0.65, 2.10; p = 0.002) remained significant predictors of DD.

Discussion

We found that both argan spinosa oil and 1% hydrocortisone application were effective in decreasing DD. However, argan spinosa oil was 0.25 times more effective than 1% hydrocortisone ointment. These findings are notable because, to our knowledge, this study is the first to assess the effect of argan spinosa oil on DD. Investigating the effectiveness of this traditional oil would be useful in the treatment of DD, so that DD could be managed by using a readily available product. DD continues to remain a concern for parents, thus resulting in frequent hospital visits. Pediatricians often prescribe topical agents of 1% hydrocortisone or other chemical-based medications for the treatment of DD.

Use of plant-based medications for the treatment of DD is limited. Although argan spinosa oil has traditionally been used in many countries including Jordan, to improve the health of the skin, and is applied directly to the skin to reduce inflammation caused by injuries, its effects in treating DD had not been established. Argan spinosa oil consists of oleic (42%), linoleic (36.8%), palmitic (12%), stearic (6%), and linolenic (0.5%) acids. In addition, it contains tocopherols, phenols, carotenes, squalene, and fatty acids (80% unsaturated fatty acids).

Argan oil has been known for its various pharmacological properties and used as a natural remedy for acne and skin inflammation, among other conditions, for several centuries. Interestingly, the unique qualities of the phenolic profile, total phenols, and flavonoid content in argan oil (*A. spinosa*) have major determinations for their anti-inflammatory properties and antioxidant activity.

Several hypotheses have attributed the therapeutic effects of argan oil to the 1% non-saponifiable substances contained in argan oil (from *A. spinosa*). These non-saponifiable materials include a range of biologically active compounds, such as carotenes (37%), sterols (29%), triterpenic alcohols (20%), tocopherols (8%), and xanthophylls (5%).[27,33–35] We used cold-pressed and edible argan spinosa oil in this study, which is known to have healing properties, including antioxidant properties and anti-inflammatory properties.

We found that the argan spinosa oil was effective in treating DD, as was 1% hydrocortisone. Interestingly, the rate of improvement was higher with argan spinosa oil than 1% hydrocortisone ointment. Because no previous studies are available on the use of argan spinosa oil for the treatment of DD, this discussion describes its use for several other dermatological conditions. Argan spinosa oil has both antifungal and antibacterial properties.[35–37] For instance, researchers in Iraq have concluded that argan spinosa oil combined with hydrogen peroxide (H_2O_2) has an anti-pseudomonal effect, and have recommended its use for the treatment of wounds and burns, on the basis of a clinical trial. Their trial has also indicated that argan spinosa oil with H_2O_2 efficiently defeated the action of several potent antibiotics against *Pseudomonas aeruginosa*.[36] Another study has found that argan spinosa oil in a mixture with H_2O_2 is effective in treating methicillin-resistant *Staphylococcus aureus* and has concluded that this treatment decreases discomfort and has high safety.[35] Thus, argan spinosa oil is effective in treating fungal and bacterial infections. However, in both studies, the researchers added H_2O_2, whereas our study used argan spinosa oil without any additional agents.

Hydrocortisone ointment is available in varying strengths (0.05–2.5%) and is widely used in the treatment of allergic rashes, eczema, itching, and other inflammatory skin conditions. The anti-inflammatory effects of topical corticosteroids consist of vasoconstriction of the blood vessels within the upper dermis, inhibition of the release of phospholipase A2, and a direct inhibitory effect on DNA and inflammatory transcription factors.[38] Although hydrocortisone is effective in the treatment of dermatitis, reports have indicated that some traditional medicinal products are more effective. In

a study comparing products containing henna oil versus topical 1% hydrocortisone, the traditional medicine of henna oil has been found to be more effective and safer in treating radiation-induced dermatitis in patients with breast cancer. Similarly, our comparison of argan spinosa oil and 1% hydrocortisone indicated a higher rate of improvement (healing) with the use of argan spinosa oil. More frequent assessments for grading DD may provide more valid results. We graded the DD site for healing on days 1, 3, and 7. Future trials may perform DD assessment of the rate of healing on a daily basis, or at least on alternate days.

Safety is a concern in using any topical agent, including corticosteroids, in children rather than adults, because of the relatively greater quantities of absorption in children.[39–41] In our study, mothers were asked to apply the appropriate quantity of ointment evenly to the affected area to enhance safety, thus potentially explaining why no adverse effects were reported. Furthermore, the sensitivity test conducted before the use of the agents ensured the safety of both the argan spinosa oil and the 1% hydrocortisone ointment.

Both groups were similar in all maternal characteristics except for maternal employment status: a significantly higher number of mothers were employed in the argan spinosa oil group than the 1% hydrocortisone group. The characteristics of the children were similar in both groups except for two variables: the use of barrier creams and prior experience with DD. These confounding variables were statistically controlled for. The use of barrier cream was found to be a protective factor against the occurrence of diaper dermatitis. Several barrier creams have shown dermo-protective efficacy.[42] We did not identify the type of barrier cream used in our sample. Future studies may include the type of barrier cream as a variable. Poor hygiene, i.e., bathing less than once per week, was found to be a risk factor in our study. Previous studies have indicated a correlation between poor hygiene and the prevalence of dermatitis.[43,44] Poor hygiene is associated with an increase in microorganisms; the exposure of the skin to urine and feces, and changes in the microclimate, thus making diapered areas susceptible to dermatitis. Therefore, regular bathing and showering increase hygiene, hydration, and the integrity of the skin. Practical management of children with DD may be supported by the removal of infectious organisms, irritants, or allergens.[43,45] The use of soap can remove numerous irritants, including colonized microorganisms as well as sweat and dust.[42,45] Similarly, Penders et al. have stated that exposure to a source of disease increases susceptibility to allergies, including atopic dermatitis.[46] We assessed these protective and risk factors before the intervention. Although mothers were advised against the use of barrier creams and soaps, these practices were not observed. However, compliance with the treatment was assessed through self-reports from mothers during video calls and home visits.

Furthermore, a decrease in the frequency of bathing might have been attributable to this study's having been conducted during the winter season. The results might have also been influenced by seasonal differences in the skin pH. In fact, skin pH is significantly associated with the skin's antimicrobial features: higher bacterial counts are retrieved from skin with alkaline pH values,[47,48] and are frequently seen during hot weather or when an infant is overdressed during the winter season.[48–50] Nurses, midwives, and clinicians play crucial roles in recognizing groups at risk of DD and promoting the best possible skin care practices.

Strength and limitations

A strength of this study is that, to our knowledge, it is the first to compare the effects of argan spinosa oil and 1% hydrocortisone in the treatment of DD. An appropriate sample size was used, with random allocation of participants. The dropout rate was low, thereby diminishing the sampling bias. This study also has several limitations. The study setting included three hospitals and affiliated healthcare centers located in the same region, thus decreasing the generalizability of the results to other settings. Furthermore, the sample in this study might not be representative of all Jordanian children 2 years of age or younger. Furthermore, because this study was conducted during winter, the results might have been influenced by seasonal differences in skin pH. Although the groups did not differ at baseline in the type of diapers used, we did not control for the type of diaper during the intervention, although diaper type might potentially have affected the healing process. Future studies may consider controlling for diaper type as a variable. Follow-up for the rate of healing could also be performed on a daily basis for more valid results.

Conclusion

The study showed that topical application of argan spinosa oil is a safe and efficient treatment for DD in children 1–24 months old. Although both argan spinosa oil and 1% hydrocortisone ointment were effective in healing DD, the rate of healing was faster with argan spinosa oil. Considering the potential hazards of topical corticosteroids and the greater efficacy of argan spinosa oil than 1% hydrocortisone, we suggest use of argan spinosa oil as an alternative treatment. Given the availability of argan spinosa oil in the Mediterranean region, it could be used as a home remedy. However, clinical trials on larger samples of children with varying degrees of DD, and more effective methods of observation and follow-up, are required to clarify the efficacy of argan spinosa oil.

Source of funding

This work was supported by the Deanship of Research at Jordan University of Science and Technology (grant number 20180008, 2017).

Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

Before the study was conducted, ethical approval was obtained from the Jordan University of Science and

Technology in October 2017 (ref# 20170528) and the Jordanian Ministry of Health in January 2018 (MOH REC 180026). The trial registration code was NCT04210674. All aspects of the Declaration of Helsinki were observed.

Authors' contributions

ESA conceived and designed this study. ESA collected, organized, and interpreted the data. JLD and ESA wrote, critically reviewed, and approved the final draft of the manuscript. ESA corresponded with the journal and addressed the editor's and reviewer's comments. All authors have critically reviewed, approved the final draft, and are responsible for the content and similarity index of the manuscript.

Acknowledgments

The authors thank the children and their families who participated in the study, the Jordan University of Science and Technology, King Saud University Medical City, and the Bahrain Nursing Society First International Nursing & Midwifery Conference.

References

1. Alghamdi MA, AL-Ghamdi HS, AlHajji AM, Alzahrani SA, Al-Thobaiti LY, Alzahrani SA, et al. Prevalence and risk factors of diaper dermatitis among newborn babies to two years of age in Al-Baha region, KSA. **Middle East J Family Med 2022**; 7(10): 47.
2. Blume-Peytavi U, Hauser M, Lünnemann L, Stamatas GN, Kottner J, Garcia Bartels N. Prevention of diaper dermatitis in infants—a literature review. **Pediatr Dermatol 2014**; 31(4): 413–429.
3. Cohen B. Differential diagnosis of diaper dermatitis. **Clin pediatr 2017**; 56(5_Suppl): 16S–22S.
4. Punjal D, Mesariya S, Patel R, Gohil D, Patel S, Patel K, et al. A descriptive study to assess the knowledge regarding prevention of diaper dermatitis among mothers of below 3 years children residing in Ahmedabad city with a view to develop an information booklet. **J Nur Today 2019**; 11(1).
5. Kim JS, Jeong YS, Jeong EJ. Knowledge of diaper dermatitis and diaper hygiene practices among mothers of diaper-wearing children. **Child Health Nurs Res 2019**; 25(2): 112–122.
6. Li CH, Zhu ZH, Dai YH. Diaper dermatitis: a survey of risk factors for children aged 1-24 months in China. **Int J Med Res 2012**; 40(5): 1752–1760.
7. Ward DB, Fleischer AB, Feldman SR, Krowchuk DP. Characterization of diaper dermatitis in the United States. **Arch Pediatr Adolesc Med 2000**; 154(9): 943–946.
8. Merrill L. Prevention, treatment and parent education for diaper dermatitis. **Nurs Womens Health 2015**; 19(4): 324–337.
9. Esmaeilzadeh H, Qolizadeh A, Hosseini S, Norouzi K, Mafi M, Rafiei H. Incidence and risk factors of diaper dermatitis in hospitalised children aged 0-24 months: an epidemiological descriptive study in Iran. **J Clin Diagn Res 2020**; 14(4).
10. Kayaoglu S, Kivanc-Altunay I, Sarikaya S. Diaper dermatitis in infants admitted to social pediatrics health center: role of socio-demographic factors and infant care. **Nurs Womens Health 2015**; 82(10): 904–908.
11. Benitez Ojeda AB, Mendez MD. Diaper Dermatitis [Internet] [cited 2021 Feb 14]. In: *StatPearls [Internet]*. Treasure Island (FL): StatPearls Publishing; 2021. Available from: https://www.ncbi.nlm.nih.gov/books/NBK559067/.
12. Odio M, Thaman L. Diapering, diaper technology, and diaper area skin health. **Pediatr Dermatol 2014**; 31: 9–14.
13. Blume-Peytavi U, Kanti V. Prevention and treatment of diaper dermatitis. **Pediatr Dermatol 2018**; 35: s19–s23.
14. Hebert AA. A new therapeutic horizon in diaper dermatitis: novel agents with novel action. **Int J Womens Dermatol 2021**; 7(4): 466–470.
15. Cartotto R. Topical antimicrobial agents for pediatric burns. **Burns Trauma 2017**: 5.
16. Blanco D, van Rossem K. A prospective two-year assessment of miconazole resistance in *Candida* spp. with repeated treatment with 0.25% miconazole nitrate ointment in neonates and infants with moderate to severe diaper dermatitis complicated by cutaneous candidiasis. **Pediatr Dermatol 2013**; 30(6): 717–724.
17. Seifi B, Jalali S, Heidari M. Assessment effect of breast milk on diaper dermatitis. **Dermatol Reports 2017**; 9(1).
18. Al-Faraidy NA, Al-Natour SH. A forgotten complication of diaper dermatitis: granuloma gluteale infantum. **J Fam Community Med 2010**; 17(2): 107.
19. Fair RJ, Tor Y. Antibiotics and bacterial resistance in the 21st century. **Perspect Medicin Chem 2014**; 6. PMC-S14459.
20. Lagadinou M, Onisor MO, Rigas A, Musetescu DV, Gkentzi D, Assimakopoulos SF, et al. Antimicrobial properties on non-antibiotic drugs in the era of increased bacterial resistance. **Antibiotics 2020**; 9(3): 107.
21. Keshavarz A, Zeinaloo AA, Mahram M, Mohammadi N, Sadeghpour O, Maleki MR. Efficacy of traditional medicine product henna and hydrocortisone on diaper dermatitis in infants. **Iran Red Crescent Med J 2016**; 18(5).
22. El Sakka A, Abdulrhman M, Shehata IH. Comparison between topical application of honey, bees wax and olive oil propolis extract and nystatin for treatment of diaper dermatitis in infants. **Int J Pediatr Child Health 2013**; 1(4): 39–42.
23. Kiechl-Kohlendorfer U, Berger C, Inzinger R. The effect of daily treatment with an olive oil/lanolin emollient on skin integrity in preterm infants: a randomized controlled trial. **Pediatr Dermatol 2008**; 25(2): 174–178.
24. Anand U, Jacobo-Herrera N, Altemimi A, Lakhssassi N. A comprehensive review on medicinal plants as antimicrobial therapeutics: potential avenues of biocompatible drug discovery. **Metabolites 2019**; 9(11): 258.
25. Oguntibeju OO. Medicinal plants with anti-inflammatory activities from selected countries and regions of Africa. **J Inflamm Res 2018**; 11: 307.
26. Panahi Y, Sharif MR, Sharif A, Beiraghdar F, Zahiri Z, Amirchoopani G, et al. A randomized comparative trial on the therapeutic efficacy of topical aloe vera and *Calendula officinalis* on diaper dermatitis in children. **Sci World J 2012**; 2012.
27. Charrouf Z, Guillaume D. Argan oil: occurrence, composition and impact on human health. **Eur J Lipid Sci Technol 2008**; 110(7): 632–636.
28. El Abbassi A, Khalid N, Zbakh H, Ahmad A. Physicochemical characteristics, nutritional properties, and health benefits of argan oil: a review. **Crit Rev Food Sci Nutr 2014**; 54(11): 1401–1414.
29. Charan J, Biswas T. How to calculate sample size for different study designs in medical research Indian journal of psychological medicine. How to calculate sample size for different study designs in medical research. **Indian J Psychol Med 2013**; 35(2): 121–126.
30. Davis JA, Leyden JJ, Grove GL, Raynor WJ. Comparison of disposable diapers with fluff absorbent and fluff plus absorbent polymers: effects on skin hydration, skin pH, and diaper dermatitis. **Pediatr Dermatol 1989**; 6(2): 102–108.

31. Baldwin S, Odio MR, Haines SL, O'Connor RJ, Englehart JS, Lane AT. Skin benefits from continuous topical administration of a zinc oxide/petrolatum formulation by a novel disposable diaper. **J Eur Acad Dermatol Venereol 2001**; 15: 5–11.
32. Campbell RL, Seymour JL, Stone LC, Milligan MC. Clinical studies with disposable diapers containing absorbent gelling materials: evaluation of effects on infant skin condition. **J Am Acad Dermatol 1987**; 17(6): 978–987.
33. El Idrissi Y, El Moudden H, El-Guezzane C, Bouayoun T, Dahrouch A, Chahboun N, et al. The influence of the forms on the quality, chemical composition and antioxidant activity of argan oil grown in Morocco. **J Microbiol Biotechnol Food Sci 2023**; 12(4): 5794.
34. Lall N, De Canha MN, Szuman K, Charrouf Z, Davids LM, Rademan S. The anti-proliferative and anti-bacterial activity of argan oil and crude saponin extract from *Argania spinosa* (L.) Skeels. **Pharmacogn J 2019**; 11(1).
35. Naher HS, Al-Saffar AP, Al LD. Argan oil as a novel anti-methicillin resistance Staphylococcus aureus (MRSA), Iraq. **Int J Eng Res 2014**; 14(3).
36. Al-Saffar AK, Al-saffar HK, Naher HS, Al-Khafaji NS, Al-Dahmoshi HO. Anti-pseudomonal effect of argan oil on *Pseudomonas aeruginosa* recovered from burn patients in Hilla City, Iraq. **Int J Sci Res 2015**; 1(2): 23–27.
37. Aureus S, Habeeb Saheb Naher B, Kadhim Al-Saffar A, Oleiwi Muttaleb Al-Dahmoshi H, Salman Al-Khafaji N, Saadallah Naji N, et al. Argan oil as a novel anti-methicillin resistance Staphy. Type: double blind peer reviewed. **Int Res J Pub: Glob J Inc 2014**; 14.
38. Gabros S, Nessel TA, Zito PM. *Topical corticosteroids*. *StatPearls*. Treasure Island (FL): StatPearls Publishing; 2020.
39. Heickman LK, Ghajar LD, Conaway M, Rogol AD. Evaluation of hypothalamic-pituitary-adrenal axis suppression following cutaneous use of topical corticosteroids in children: a meta-analysis. **Horm Res Paediatr 2018**; 89: 389–396.
40. Telofski LS, Morello AP, Mack Correa MC, Stamatas GN. The infant skin barrier: can we preserve, protect, and enhance the barrier? **Dermatol Res Pract 2012**; 2012.
41. Sharp M. Diaper dermatitis algorithm quality improvement initiative to decrease incidence of and severity of diaper dermatitis using a reliable and valid scoring tool in the Neonatal Intensive Care Unit (NICU). **WCET 2022**; 42(3).
42. Mostosi C, Simonart T. Effectiveness of barrier creams against irritant contact dermatitis. **Dermatology 2016**; 232(3): 353–362.
43. Kim H, Ban J, Park MR, Kim DS, Kim HY, Han Y, et al. Effect of bathing on atopic dermatitis during the summer season. **Asia Pac Allergy 2012**; 2(4): 269–274.
44. Dickman M, Dawson AL, Dellavalle RP. The relationship between hygiene and microbial burden in atopic dermatitis risk based on a systematic review. **Arch Dermatol 2012**; 148(8): 936–938.
45. Carr AN, DeWitt T, Cork MJ, Eichenfield LF, Fölster-Holst R, Hohl D, et al. Diaper dermatitis prevalence and severity: global perspective on the impact of caregiver behavior. **Pediatr Dermatol 2020**; 37(1): 130–136.
46. Penders J, Gerhold K, Thijs C, Zimmermann K, Wahn U, Lau S, et al. New insights into the hygiene hypothesis in allergic diseases: mediation of sibling and birth mode effects by the gut microbiota. **Gut Microbes 2014**; 5(2): 239–244.
47. Bender JK, Faergemann J, Sköld M. Skin health connected to the use of absorbent hygiene products: a review. **Dermatol Ther 2017**; 7(3): 319–330.
48. Ali SM, Yosipovitch G. Skin pH: from basic science to basic skin care. **Acta Derm Venereol 2013**; 93(3): 261–269.
49. Paller AS, Mancini AJ. Paller and Mancini-Hurwitz Clinical Pediatric Dermatology E-Book: A textbook of skin disorders of childhood and adolescence. **Elsevier Health Sci 2020**: 23–27.
50. Shin HT. Diagnosis and management of diaper dermatitis. **Pediatr Clin 2014**; 61(2): 367–382.

How to cite this article: Alsatari ES, AlSheyab N, D'Sa JL, Gharaibeh H, Eid S, Al-Nusour EA, Hayajneh AA. Effects of argan spinosa oil in the treatment of diaper dermatitis in infants and toddlers: A quasi-experimental study. J Taibah Univ Med Sc 2023;18(6):1288–1298.